Resource Agency Programs

Texas Water Commission Water Quality Monitoring Program in the Galveston Bay System

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The Texas Water Commission (TWC) is the primary state agency responsible for protecting surface and ground water quality within Texas. In order to accomplish this goal and monitor the effectiveness of water quality management programs the agency actively monitors the surface water quality of the State's streams, rivers, lakes, estuaries and nearshore marine waters. This task is accomplished through the Surface Water Monitoring Program (SWM). Currently the SWM addresses the following information needs:

1. Description of existing water quality in streams, reservoirs and bays;

2. Monitoring of impact of industrial, municipal and agricultural point source discharges on water quality;

3. Assessment of water quality impacts from spill events;

4. Assessment of long-term trends in water quality;

5. Comparison of existing water quality and established water quality standards (waste load allocations, water quality standards); and

6. Activities and management decisions pertaining to the Texas Water Code and Federal Clean Water Act (permits, waste load allocations, water quality standards, etc.).

Currently, selected water quality parameters are summarized every two years and presented in the *State of Texas Water Quality Inventory*. The *Water Quality Inventory* is prepared and submitted to the EPA by the Texas Water Commission in accordance with Section 305(b) of the Clean Water Act. This document provides information on current monitoring data for some parameters, and water body segment uses, standards, and problem areas.

The SWM is routinely used to assess the impacts of permitted discharges and/or spills on water quality. Sampling stations are strategically located in water bodies to assess the single and/or cumulative impacts of permitted discharges and spill events. Depending on the chemical characteristics of the waste discharges being investigated, additional parameters not routinely monitored are also sampled. These parameters may include heavy metals and/or pesticides. Results of routine monitoring are often referred to wastewater inspectors for follow-up investigations of suspected sources.

Long-term monitoring data sets are routinely used to discern trends in various

parameters. For example, historical data on dissolved oxygen have shown a gradual improvement in dissolved oxygen levels within the Houston Ship Channel during the last ten years. In addition, nutrient data for some segments have exhibited seasonal and yearly patterns within the bay system. Good quality long-term data sets for dissolved oxygen, pH, water temperature, conductivity, nutrients, pesticides in water and sediment, and fecal coliform bacteria currently exist for the majority of the major water body segments in Galveston Bay. To a lesser extent, total metals in water and sediment data are also available for the bay system.

Historical data are also used to evaluate attainment of targeted water quality standards for each segment and/or evaluation and revision of existing standards. Existing and new pollution control technology can be evaluated for effectiveness. Decisions on the promulgation of new regulations and/or modifications of existing management strategies are often based on results of monitoring data. Inclusion of water bodies on the 304(l) toxicants list is an example in which routine water quality data were used to target problem areas.

Currently there are 58 water quality monitoring stations located within the immediate Galveston Bay watershed. Thirty-eight of these stations are located within the open-bay segments. Surface water sampling for conventional parameters (nutrients, etc.) is conducted at all of these segments. In addition, more limited sampling of sediment, fish tissue and biological communities (nekton, benthics) is conducted at selected stations. Water sampling includes hydrological profiles of the water column at each station and collection of surface water samples at designated intervals for selected chemical constituents. When bottom water samples are required, a Kemmerer water sampler is used.

Sediment and benthic samples are collected with Ekman and/or Peterson dredges. Nekton are collected with gillnets, seines and stationary revolving intake screens located primarily within the Houston Ship Channel. Starting this year the TWC will also be conducting ecoregion monitoring of tidal tributaries for nekton (fish and macroinvertebrates) as part of a wider state-wide effort to characterize ecoregions. This data will be used for development of water quality standards and permitting. In addition to routine monitoring, the TWC has also conducted many intensive surveys and special studies on selected watersheds (e.g., Houston Ship Channel, Dickinson Bayou, and permit site assessments etc.) in support of permitting issues and waste load allocations.

Water and sediment samples collected from the SWM are submitted to the agency and contract labs for analyses. Each of these laboratories are required to follow EPA protocol for quality assurance/quality control (QA/QC). These chemical data are then entered with any accompanying biological data into the TWC water quality database in Austin. Currently the agency has data in computerized format for many stations back to 1968. Monitoring data is readily available from the Austin office in various forms including hard copy and PC-compatible formats (e.g., ASCII, LOTUS etc.). This information is normally provided free of charge to state agencies and university researchers. Private individuals are usually charged for copying and/or computer time. In addition to the computer data bases discussed, there are numerous published reports dealing with various

aspects of water quality within the Galveston Bay watershed that are available from the TWC. Depending on the recommendations of the GBNEP Management Conference and available resources, future monitoring of Galveston Bay will hopefully increase. Since 1974 the SWM has undergone a state-wide reduction of 15% of the historical sampling stations and 54% reduction in sampling events, mainly as a result of budgetary constraints. It is important that this trend not continue. Without sound monitoring programs, it is difficult to evaluate the effectiveness of our past actions or to improve our future management of Galveston Bay.

Texas Parks and Wildlife Monitoring Program in the Galveston Bay Complex

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The Texas Parks and Wildlife Department (TPWD) has conducted research on the Galveston Bay complex since the early 1950s. Commercial landings have been monitored since 1936. Eastern oyster (*Crassostrea virginica*) population studies began in the early 1950s and shrimp (*Penaeus* spp.) studies in the late 1950s. Hydrological data have been collected on a routine basis since the mid-1950s.

The overall management approach utilized by the TPWD for Galveston Bay changed in the mid 1970s. Prior to 1974, most studies dealt with oyster and shrimp populations, ecological aspects of the bay, or targeted specific problems. Average length of the ecological studies was about two years. Examples of ecological studies conducted during this interval include the Christmas Bay, Chocolate Bay and Cedar Bayou-Trinity Bay studies. Almost all studies conducted prior to 1974 are contained in Department project reports. The only information computerized is the Hydrological Study data.

Beginning in 1974 the TPWD embarked on a long term Coastwide Monitoring Project which included Galveston Bay. Two programs, Harvest and Resource Monitoring, require two administrative personnel, three biologists, eight technicians, and a master/pilot, all stationed at the Seabrook Laboratory. Overall direction for the Programs is coordinated from the Rockport Laboratory.

The objectives of the Harvest Program, in existence since 1974, are to monitor trends in socioeconomic characteristics, landings, angling pressure and catch/effort of sport-boat fishermen in order to assess the need for and impact of saltwater fishing regulations. Private boat, charter boat and head boat fishermen are surveyed annually; shore-based fishermen are monitored every 5-10 years. Commercial fishermen are monitored through a self-reporting system, through a cooperative effort with the National Marine Fisheries Service, and through on site and aerial surveys. The Harvest Program generally uses on-site surveys to collect interview data. Survey sites are selected at random but are weighted according to information obtained during roving counts. Therefore, access sites with high activity are surveyed more often than those with low activity. Although survey sites are selected to maximize the number of sport fishing interviews, all user groups are interviewed. Short-term data have been collected on specialized recreational fisheries such as the spring black drum (*Pogonias cromis*), fall red drum (*Sciaenops ocellata*), fall flounder (*Paralichthys* sp.) and winter spotted seatrout (*Cynoscion nebulosus*) fisheries.

The objectives of the Resource Program, in existence since 1976, are to: 1) develop long term trend information on finfish and shellfish population abundance and stability; 2) monitor environmental factors which may influence finfish and shellfish availability; and 3) determine growth, mortality and movement of selected species through recapture of tagged fish and by scale analyses. To

ensure random sampling throughout Galveston Bay, the bay has been sectioned into 1-minute latitude by 1-minute longitude grids. Each grid has been subdivided into 144 "gridlets". With this system each section of shoreline and open bay water has an equal chance to be sampled. All sites are selected randomly before going to the field. Five sampling gears are utilized in the Galveston Bay complex and in the gulf off Galveston. In the bay 18.3 m long bag seines, 182.9 m long gill nets, 6.1 m wide trawls and standardized oyster dredges are used. In the Texas Territorial Sea 6.1 m wide trawls, 60.9 m long beach seines and 18.3 m bag seines are utilized. All organisms caught in a gear are processed. Dissolved oxygen, temperature, salinity, and turbidity are collected with each sample. During one year 1,470 samples (about 122 samples/month) are collected.

All data for both the Harvest and Resource Programs are stored on computer. An overview of all data is published annually in the TPWD's Management Data Series. Data collected on both Monitoring Programs have been used to develop coastwide Management Plans for shrimp and Eastern oyster. Management plans are being developed for red drum, black drum, spotted seatrout, sheepshead (*Archosargus probatocephalus)*, southern flounder (*P. lethostigma*), and blue crab (*Callinectes sapidus*). Resource and harvest data have been used to set the dates of the annual Texas closure in the Gulf, to assess impacts of catastrophic events (i.e., freezes, red tide), and have been used by the TPWD and outside entities to address items of environmental concern.

In addition to both monitoring programs, numerous special projects of interest are conducted in cooperation with area universities, the federal government, other state agencies, and local organizations. Special projects include, but are not limited to: oyster disease assessment; electrophoresis analyses of spotted seatrout, red drum and black drum; mitochondrial DNA analysis of red drum; commercial assessment of striped mullet, (*Mugil cephalus*); and finfish and shellfish tagging studies. The number and complexity of special projects is generally limited by manpower and budget constraints, but the TPWD makes effort to incorporate special projects into the routine monitoring program. Most of these special projects will be published in-house or in peer-reviewed journals.

The present TPWD monitoring programs have evolved since 1974 through systematic appraisal of objectives. The programs are designed so new items of concern can be addressed without jeopardizing the overall program objectives. TPWD monitoring programs are based on statistical approaches and are defensible in court. With these programs in place it is possible to preserve and enhance the natural resources of the Galveston Bay complex.

History and Status of the Texas Molluscan Shellfish Regulatory Program

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The National Shellfish Sanitation Program (NSSP) was established in 1925 to provide guidelines for the safe production and consumption of molluscan shellfish (oysters, clams and mussels), which are normally eaten whole and raw. Under the program, the states agreed to adopt necessary laws and rules to administer the program, to survey and classify shellfish growing areas and to inspect and certify the shippers and processing plants in conformance with the guidelines established by the NSSP. The shellfish industry agreed to harvest shellfish only from approved areas and to ship and process shellfish in conformance with the laws and rules. The role of the federal government was to evaluate the state programs and the level of industry conformance and to either endorse or withhold endorsement of the state program based on the level of conformance by the state and the industry. A *Manual of Recommended Practice* providing the guidelines was developed in two parts: *Part I - Classification of Shellfish Growing Areas*, and *Part II - Sanitation of the Harvesting and Processing of Shellfish*. This program worked well until the late 1970s.

Changing events in the 1970s led to a need for a more responsive and more flexible program. In 1982, the Interstate Shellfish Sanitation Conference (ISSC) was established to replace the NSSP. The Conference operates on much the same principles, but meets annually to consider revisions in the manuals and to resolve procedural issues. During the 1983-1987 period, major updates and revisions were made to the manuals, consistent with the scientific knowledge available.

State law in Texas provides that shellfish in Texas must come from a state or nation whose program conforms to the current *Manual of Recommended Practice*. Prior to the statute adoption in 1965, a voluntary program had existed in Texas. Subsequent to the statute adoption, surveys were conducted on the growing areas and the coastal systems were classified as "Approved Areas" or "Polluted Areas". Harvesting of shellfish from "Polluted Areas" is prohibited by additional statutes. Classification of an area as "Polluted" applies only to shellfish harvesting. The criteria for this classification are about fourteen times more stringent than the contact recreation standards which apply to waters that people swim in, and therefore get in their ears, nose and mouth. It is possible for relatively clean waters to fail to meet part of the criteria and to be classified as "Polluted". Classifications remained fairly stable throughout the 1970s and into the middle 1980s. With the revisions in the manuals, and with increased emphasis of the Texas Shellfish Program, a complete resurvey of the Texas coast was completed in 1988, and several changes in classifications were made, including establishment of six Conditionally Approved Areas. During the last two years, a few minor changes have occurred, but in general the classifications have been stable. The classifications are to be reviewed every three years, with complete resurveys to be completed at least every twelve years.

The sanitary surveys conducted by the Department of Health consist of four parts:

1. A pollution source survey to determine types, quantities and discharge points of all pollution;

2. A hydrographic survey to determine the physical characteristics of the receiving waters, i.e., depth, volume, currents, tides, etc.;

3. A meteorological survey to determine weather patterns and the effects of weather events on pollution sources and receiving waters; and

4. A bacteriological survey consisting of water samples from selected stations which represent the potential pollution impact on the system to determine if actual pollution extends beyond the potential pollution areas determined from the first three parts of the survey.

Areas which have potential for pollution or which have results of the bacteriological survey exceeding the established criteria are classified as "Polluted". If sufficient samples can be collected to evaluate all types of weather conditions and the resultant effects on the system, and the results of the bacteriological survey indicate that under some conditions the "Polluted" areas, or portions of them, are not impacted by the pollution to exceed the criteria, and certain other specific requirements can be met, the areas can be operated as Conditionally Approved, and can be open to harvest under specified conditions.

Current shellfish classifications in the Galveston Bay complex are as follows: 140,285 acres Approved, 44,060 acres Conditionally Approved, and 150,220 acres "Polluted", (see maps dated November 1, 1990). The Conditionally Approved area 1 is open for harvesting until greater than two inches of rain is recorded in San Leon in seven days, and areas 2 and 3 are open for harvesting until greater than two inches of rain is recorded in Baytown in seven days or the Trinity River rises to higher than nine feet at Moss Bluff. The majority of the "Polluted" area is available for transplanting, with some thirteen small areas prohibited in the immediate vicinity of sewage treatment plant outfalls, and a larger section of northwest Galveston Bay in the vicinity of Morgan Point being prohibited because of chemical contamination. Transplanting is not allowed out of West Bay.

Approximately 1,200 bay water samples were collected in the Galveston Bay Complex in 1990, and were analyzed for fecal coliform bacteria. At the same time, various physical and chemical measurements were taken at the sampling locations. All of the data is recorded in computer at the Department of Health in Austin. Historical records of fecal and total coliform bacteria and physical/chemical measurements dating back to 1958 are recorded also. All of the applicable data is used in the re-evaluation of each station, each year for Conditionally Approved areas and every three years for all other areas. Re-evaluations can be conducted at more frequent intervals if changing situations indicate the need.

Fisheries Management Research in Galveston Bay

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Our management research addresses brown shrimp (*Penaeus aztecus*) and white shrimp (*Penaeus setiferus*) fisheries in Galveston Bay and offshore. This is done by monitoring penaeid shrimp populations at various stages in their life cycles and determining stock size in relation to various environmental conditions. By predicting the commercial shrimp harvest, we enable fishermen to prepare for the harvest before the season opens, suggest where the fishing will be best, and determine what catch rates may be expected. This information also is used to assist the Gulf Fisheries Management Council, National Marine Fisheries Service (NMFS) and state agencies in management and conservation of shrimp resources.

One of our activities is forecasting annual brown shrimp harvests from offshore Texas using Galveston Bay as the data source. One objective is the identification of pertinent habitat and environmental factors which govern recruitment success for brown shrimp. Similar management research is underway to develop the potential of forecasts for white shrimp.

Monitoring of Texas brown shrimp recruitment begins with weekly sampling of postlarval shrimp that enter Galveston Bay and other Texas bays during the early part of the year. Postlarval brown shrimp abundances are sampled at Bolivar Roads each spring. Temperature and rainfall data are obtained from the Galveston office of the National Weather Service, and water height data from the Pier 21 gage operated by the National Ocean Service. The data are analyzed in a multiple regression model developed to give shrimpers a two-month lead time before the major fishing begins. Understanding the effects of weather fronts ("northers") on postlarval brown shrimp immigration is an essential part of improving the prediction of annual brown shrimp harvest. These distinctive phenomena are addressed by putting special emphasis on sampling intensively before, during and after passage of cold fronts. Also, we are assessing the cross-channel variations in postlarval shrimp abundance as well as the effects of variable coastal currents, through satellite imagery, on recruitment to Galveston Bay.

These activities are followed by quantitative sampling of juvenile shrimp in various estuarine habitats from spring through fall to assess the carrying capacity of the habitat and the condition of the juvenile shrimp. The Galveston Bay bait shrimp fishery is monitored to check abundances of subadult shrimp as they begin their movement out of the estuaries back towards the Gulf of Mexico. These data are a prime indicator of the potential Texas harvest of brown shrimp for the year.

Sampling conducted in offshore waters of Texas through the Southeast Area Monitoring and Assessment Program (SEAMAP) is another means of examining

the size and abundance of shrimp stocks before and after the fishing season. In addition, hydrographic, environmental and ecological factors which modify coastal and estuarine habitats are analyzed with these biological data. Such monitoring helps to delineate the important conditions and events, such as floods or hurricanes, that govern recruitment success of each shrimp species. Remote sensing with ground truth verification also assists in our understanding of the coupling of environmental conditions and shrimp productivity.

A model of shrimp mortality in estuaries is under development to determine possible effects of habitat loss and physical alteration of Galveston Bay on annual recruitment levels of brown shrimp. The objective of this project is to construct a simulation model of shrimp burrowing, which has been shown to be a major predator avoidance behavior. Laboratory and field experiments are being used to define important factors regulating burrowing of brown shrimp and to construct a simulation model to describe this behavior.

Much of the data used in these fishery management operations are collected through year-round interviews of bay, bait, and offshore shrimpers by our port agents. While this may be the least glamorous of jobs, it is perhaps most important in actually describing the shrimp fishery. Shrimp catch and effort data are collected and exchanged with state agencies for their information on other fishery species such as blue crabs (*Callinectes sapidus*) and finfish. In this manner, both federal and state management agencies benefit from data collection.

Overview of Environmental Studies for the Houston-Galveston Navigation Channels, Texas Project

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The January 8, 1990 Chief of Engineers' Report recommended that the Corps of Engineers conduct additional environmental studies of the proposed enlargement of the Houston and Galveston Ship Channels to help answer environmental concerns raised by resource agencies. The proposed channel project, scheduled to be constructed in two phases, includes plans to deepen the Houston Ship Channel (HSC)) from the existing 40-foot depth to 45 feet, and widen it from 400 to 530 feet in the first phase. A 450- foot wide section of the 1,125-foot wide Galveston Channel would be deepened from the existing 40-foot depth to 45 feet. Phase two plans for both channels to be deepened to 50 feet and the HSC to be widened to 600 feet.

In subsequent meetings between the Assistant Secretary of the Army, the Corps, and resource agencies, agreement was reached that the environmental studies would be completed and incorporated into a Supplement to the Final Environmental Impact Statement (SEIS) prior to seeking construction authorization from Congress. Engineering and design work on the project will continue in the mean time along with the environmental studies. The agencies also agreed to make every effort to ensure that the studies and SEIS are completed on schedule.

To foster better coordination between the Galveston District of the Corps and the resource agencies concerning the development of these additional environmental studies, an Interagency Coordination Team (ICT) was formed and has met since January 1990. To date, the ICT has successfully agreed on the Scopes of Work (SOW) for the following technical studies: a Hydrodynamic and Salinity Model Study, a Ship Handling Simulation Model Study, a Oyster Model Study, a Contaminants Study, and procedures and methodology for developing a plan for beneficial uses of project dredged material, assessing cumulative impacts of all major projects in Galveston Bay, and locating and designing mitigation oyster reefs. In addition, the ICT agreed on the science for a Benthic Recovery Study which subsequently received Washington-level approval. Except for the Benthic Recovery Study, the additional studies are to be completed by October 1992 and will add approximately $6.7 million to the project budget. The draft SEIS is scheduled for public review in April, 1993.

Three of the previously mentioned studies are being conducted by the Corps' Waterways Experiment Station (WES) at Vicksburg, Mississippi. The WES Hydrodynamic and Salinity Model Study will use three-dimensional RMA-10 computer modeling to assess the effect of the channel improvements and dredged material disposal plans on water circulation and salinity patterns in Galveston Bay. As part of model verification, two types of field investigations were conducted including a intensive 25-hour survey for vertical current and salinity data at selected Galveston Bay stations, and a long-term (180 days; July 1990-January

1991) monitoring program to obtain water level, salinity, and current data (see the abstract of Larry M. Hauck for details of the long-term field investigations).

The WES Ship Handling Simulation Model Study will aid in refining the recommended channel size and alignments by tests of computerized and scale models of ship movements, including passings, at different sections for both existing conditions and proposed enlargement dimensions. Ship pilots who presently navigate the existing channels will participate in the model runs. In November 1990, ship positioning equipment was placed on separate inbound and outbound ships to obtain continuous ship position data (Global Positioning System-GPS) during approach, meeting, and passage maneuvers of the two ships. The collected data will be used to improve the computer simulation of ship passing maneuvers.

WES has also initiated a Benthic Recovery Study to determine the rate of biological recovery on submerged new-work dredged material disposal areas in Galveston Bay. Two 23-acre experimental disposal areas are proposed to be constructed in upper and lower Galveston Bay and sampled periodically for benthic and nektonic organisms (crustaceans and fish) to evaluate the recovery rate and fishery utilization of benthic assemblages (including use of predator-exclusion caging efforts) on stiff clay habitat. Pre-disposal sampling of the proposed disposal areas have occurred (see abstracts by LaSalle, Diez, and Bass about the pre-disposal efforts).

An Oyster Model Study will be conducted by faculty from Texas A&M University and Old Dominion University to assess impacts of possible project-induced salinity changes on oyster populations in Galveston Bay. An existing oyster population dynamics computer model is being modified to incorporate larval transport and mortality by parasites (primarily *Perkinsus marinus*) and predators, and will be coupled to the WES hydrodynamic model. The model will also be used for siting new oyster reefs in Galveston Bay for project mitigation and beneficial uses of dredged material.

The ICT Cumulative Impact Subcommittee agreed that the cumulative impacts of other projects in Galveston Bay will be assessed in the project SEIS using the most recent and best information available. However, no additional studies (including field studies) to assess parameter impacts would be part of this effort. A Contaminants Study will use tiered testing procedures of increasing sensitivity to evaluate the contaminant potential of project maintenance dredged material. Test results will be used to determine the suitability of the material for disposal options, including beneficial uses. The testing procedures will follow the approach in the EPA/Corps manual: *Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Water* ("green" version for ocean disposal; "gold" version for disposal in Galveston Bay).

The ICT Beneficial Uses Subcommittee is presently working on the identification and evaluation of dredged material disposal ideas offered by the public and resource agencies to help develop a locally-preferred disposal plan. The Subcommittee will attempt to make maximum beneficial use of the material in Galveston Bay including developing wetland areas, creation of bird islands,

creation of recreational sites, creation of shore protection berms, erosion control, and forming the support base for mitigation oyster reefs.

Results of the two years of additional studies should:

1. Satisfy concerns about the project by providing extensive new scientific knowledge of Galveston Bay circulation and salinity patterns and refinement of project-induced environmental impacts to bay biota, especially to oyster populations;

2. Provide information for refinement of the project mitigation plan, especially in the siting and creation of artificial oyster reefs;

3. Lead to the development of a locally preferred disposal plan for the project;

4. Result in refinement of project ship channel design dimensions;

5. Offer the opportunity for the Corps, resource agencies, and environmental interest groups to work together to seek an acceptable project that both protects Galveston Bay resources and provides for environmentally sustainable development; and

6. Serve as a guide for future interagency coordination efforts on complex coastal projects.